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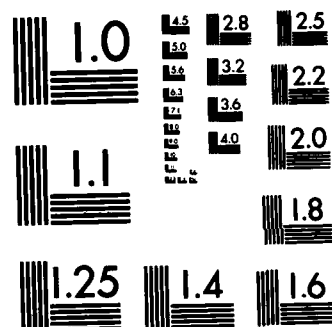
RESEARCH AND DEVELOPMENT TECHNICAL REPORT
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FORT MONMOUTH TECHNICAL DISCLOSURE BULLETIN

VOLUME 1, NUMBER 1

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Laser	Timing	Radiation Detection
Modem	Multipactor	Fuel Cells

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The Technical Disclosure Bulletin is intended as a vehicle for pub-
licizing inventions for which a patent application will not be
filed. It contains fact sheets and sketches of a number of
innovations developed at Fort Monmouth or under contract with
various companies, from the time period of December 1978 to
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FORT MONMOUTH TECHNICAL DISCLOSURE BULLETIN

Volume 1, Number 1; December 1982

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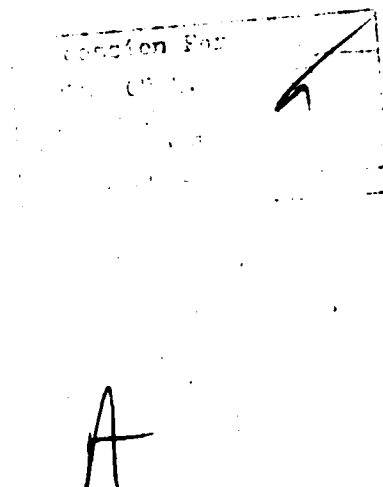
PREFACE

FORT MONMOUTH TECHNICAL DISCLOSURE BULLETIN

The following inventions have been generated by the scientific
and technical personnel of the U.S. Army, Fort Monmouth, New Jersey
and by personnel of companies under research and development
contracts with Fort Monmouth. The purpose of the bulletin is to
disclose inventions for which the filing of patent applications is
not planned, and which otherwise would remain unpublicized.

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MODEM EMPLOYING SPECTRUM CONTROL
by F.A. Wissel and D.A. Kiliman, D-1949

In communication systems where bandwidth is at a
premium, as where use of closely packed channels may occur for
instance, maximization of energy transfer is of great importance.
A modem has been proposed which will optimally contain
the energy spectrum to available bandwidth by minimizing
the out-of-band energy. The principle of operation for the
modem is a method of replacing the waveform edges of the digital
signals transferred with fractions of sinusoidal waveforms.
In this way the rising edge of a digital "one" is replaced
by a positive sine while the falling edge is replaced
by a positive cosine. Similarly, the edges of a digital zero
are replaced by negative sine and cosine. These waveforms
are normally timed so that the sum $I^2 + Q^2$ is a constant
(where I and Q respectively are the "in phase" and "quadrature
phase" modulated components). This insures a constant
envelope output and the spectral containment is both originally
achieved and maintained in an efficient, simple,and practical
overall system design. Such would allow maximization
of the in-band to out-of-band energy ratio without creating
intersymbol interference,and still allows synthesis of a
constant envelope signal. The concept of utilizing fractions of
sinusoids is believed to represent a novel approach.

Previous methods of maximizing energy transfer in
a modem had disadvantages which involved filtering digital
waveshapes to eliminate sharp edges (rise and fall times) to
reduce out-of-band energy created by the high frequency edge
components. Such filtering was either applied to the baseband

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pre-modulation circuitry or to the modulated carrier signal.
However, this filtering has two basic disadvantages, one of
which is unique to Offset QPSK modulation. The more typical
infinite impulse response (IIR) design produces delay distortion
(versus frequency) which contributes to intersymbol
interference and subsequently to poorer data error rate.
Another problem results from the desirability of preserving a
constant total envelope power (versus time) due to summation
of the two quadrature relative contributing components. If
this goal is achieved, the filtered modulated signal can be
processed through simple, efficient, non-linear amplifiers
without reintroduction of undesired spectral components.
There are a limited number of step responses for the two
quadrature channels that meet this criterion. These responses
may not be practically obtained by filtering techniques,
but can be obtained by the methods proposed in this discussion.
A block diagram of an AQPSK modulator for this modem,
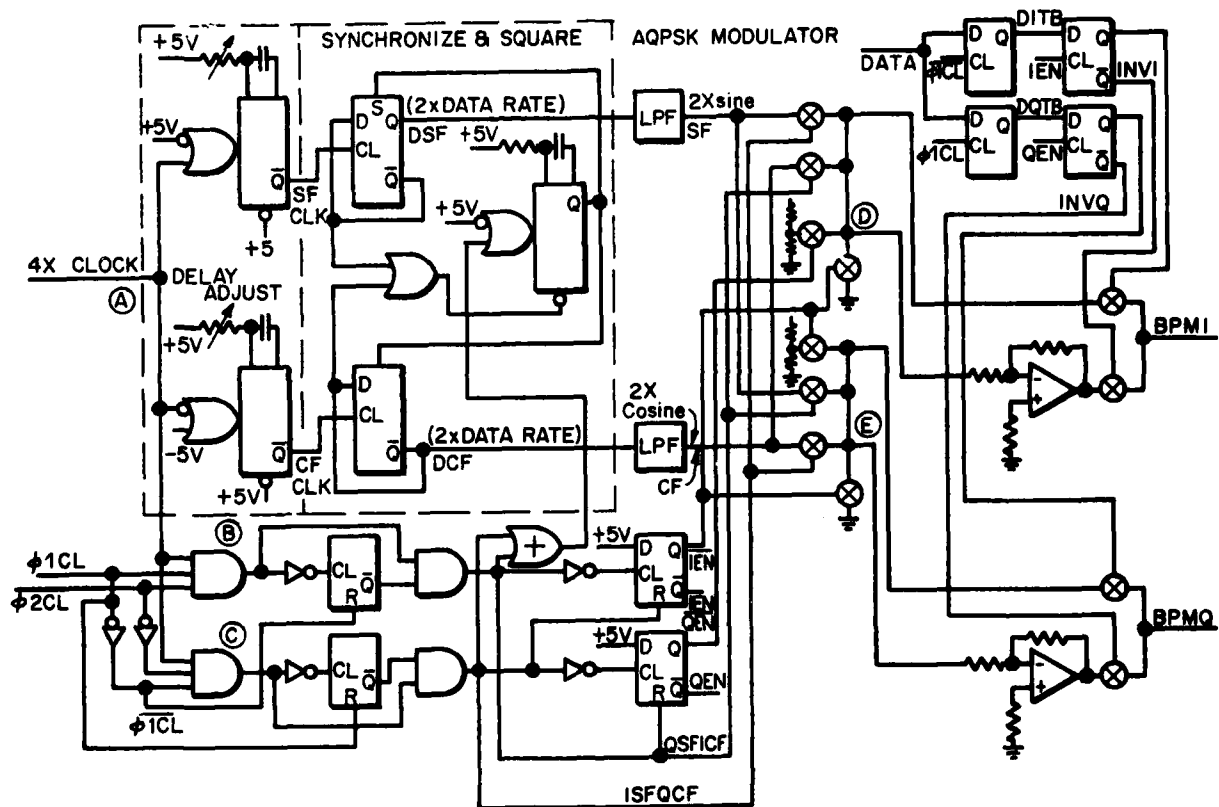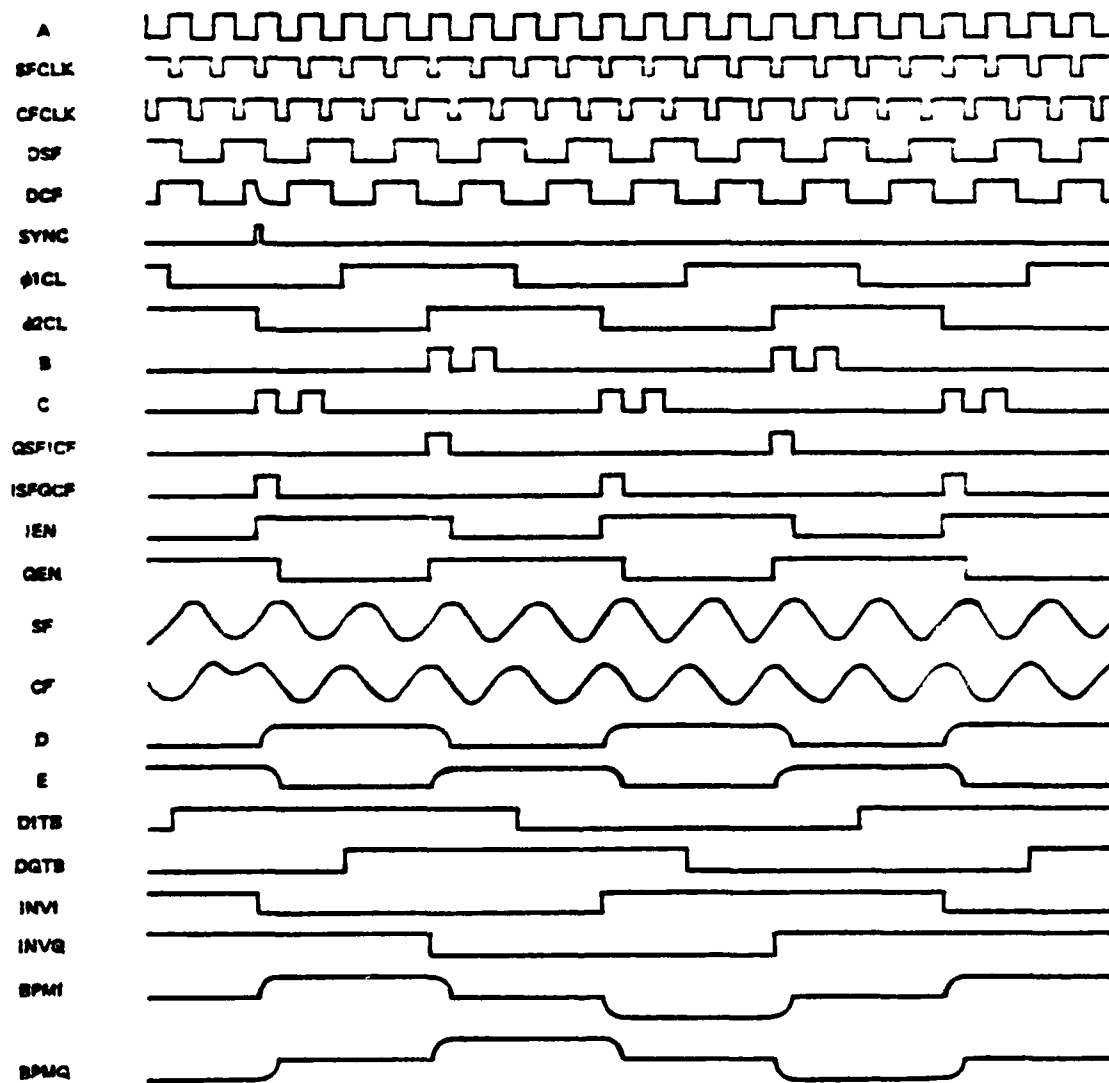and its timing and waveshape diagram appear in Figures 1-2.

FIGURE 1. MODULATOR BLOCK DIAGRAM

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AQPSK MODULATOR TIMING

FIGURE 2. MODULATOR TIMING DIAGRAM

TIMING MAINTENANCE FOR LONG RADIO FADES
by I. Havel and
J. Hackendorf, D-2030

In digital communications systems subject to random
(fade) or periodic interruptions, bit count integrity (BCI)
must be assured by timing maintenance, otherwise a loss of bit
count integrity would result in an extended system outage
while multiplexers re-frame and crypto units re-synchronize
following a fade. The conventional timing maintenance method
is to use a phase locked loop which is operated open loop
during fades. This method enables recovery from phase errors
of many cycles without losing BCI. A framing bit in the
multiplexed data stream provides a phase reference at a rate
much lower than the bit rate. By monitoring the position of
the frame bit after the fade, the number of bit cycles which
were slipped during the fade can be determined, and the loop
allowed to restore the slipped clock cycles. This principle
can be used with any digital signal containing regularly
spaced synchronization bits or characters or else additional
synchronization bits can be added.

The Figure shows a receiver modified to maintain
timing through long fades without losing bit count integrity.
An incoming signal is detected and written into a RAM buffer
with recovered timing. A WRITE ADDRESS counter is reset to
address zero each time the frame bit occurs in the data bit
stream (e.g. every 64 data bits with an eight bit buffer).
Buffer size (modulus of the address counters) must be
equal to frame length or be evenly divisible thereto. Data
is read out of the RAM buffer with the clock generated by

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the timing maintenance phase locked loop. The loop is locked
with the buffer half full. The voltage controlled oscillator
(VCO) control voltage is ac/dc converted and stored digitally
in a continuously clocked latch. When a fade is detected,
the latch clock is inhibited and the VCO frequency is held at
the last value stored before the fade. After the fade
is over, the latch clock remains inhibited until after frame
sync has been established and the frame pulses have reset the
WRITE ADDRESS counter. The loop then adjusts its frequency t
correct the phase difference between the READ and WRITE count
and restore any cycles slipped during the fade. In this eigh
bit buffer, $\pm$ 4 cycles can be slipped without losing BCI.
With a 1.0 ppm frequency error during the fade, BCI can be
maintained for 200 millisecond fades. Increasing the buffer
size (up to a maximum of the frame length) will increase
the timing maintenance period proportionally. This invention
can be used on DCI cable modems to maintain BCI for some
500 milliseconds and 8 seconds, e.g. Applications are possible
in troposcatter radio modems or in burst communications
systems. A variation of this idea can be used to maintain
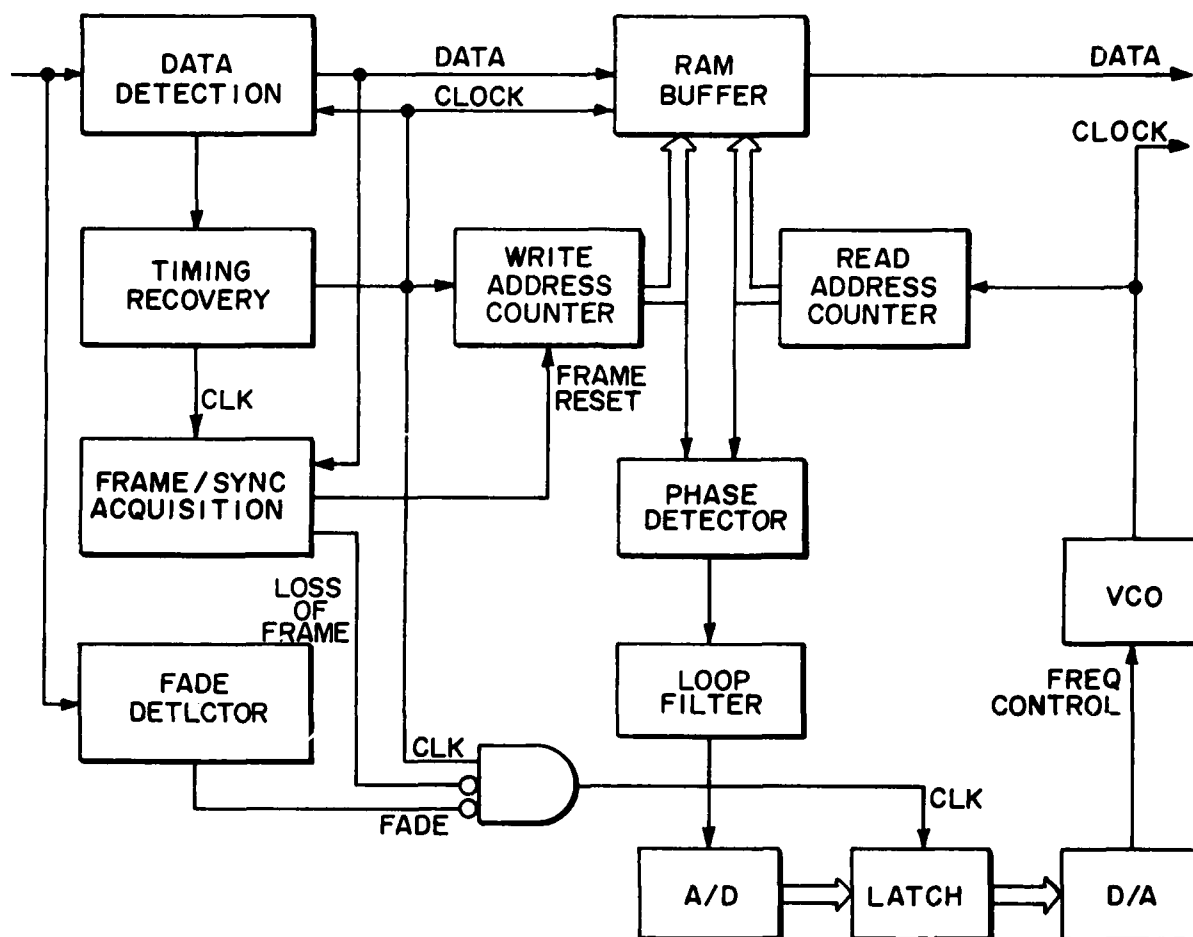bit timing from burst-to-burst in a time division demodulator.

FIGURE 1. MODIFIED RECEIVER

THIN FILM ELECTROLUMINESCENT DISPLAY
Panel by Z. Kun, D. Leksell, F. Kuo,
J. Murphy, D-2172

Thin film electroluminescent panel displays are
commonly comprised of display elements which are addressed by
means of intersecting horizontal and vertical bus bars, however,
such devices have serious addressing limitations. In the
described invention, an active rather than passive addressing
scheme is employed to improve addressing. Each element in an
array incorporates a light emitting storage capacitor as a
memory, and a pair of thin film transistors with which the
capacitor can be controlled. The procedure for depositing
an electroluminescent structure on top of a thin film transistor
(TFT) circuit array results in a spot brightness of approximately
100 foot-lamberts with an ac excitation voltage of approximately
75 volts rms, within capabilities of the TFTs to withstand the
resulting dc voltages that develop when the transistors are in
off condition. One method of combining TFTs with a thin film
electroluminescent (TFEL) display is to deposit the TFEL
structure on a glass substrate that already has the TFT circuits
on it. Another is to deposit the TFEL structure on a
glass substrate that is covered with a transparent electrode.
The TFT circuits are then fabricated on top of the TFEL
structure. In the former method, one restriction that presence
of the TFT circuits impose upon the fabrication technique of
TFEL structures is that the circuits should never be exposed
to see temperatures exceeding approximately 300 $^{\circ}$C, such as in
post zinc sulfide deposition annealing, e.g.; higher temperatures
would likely damage the semiconductor. The TFEL device should

operate at a low enough voltage which will not exceed the cap-
abilities of the TFT devices. he TFT device must be capable of
withstanding twice the full peak ac voltage applied to the
display because of charging in the TFEL capacitor when the
transistors are switched off. Also, another important
consideration is that the ac required to drive the TFEL must be
electrically isolated from the TFT gates so as not to turn
them on inadvertently. Isolation is also required in order to
minimize total capacitive current. It is possible to lower
the gate drive and voltage requirements by shunting the TFT by
a hybrid capacitor, not thin-film, if its value is high relative
to TFEL capacitance. The cell configuration described has
been successfully used in TFT matrix displays using powdered
phosphors,and liquid crystals using sophisticated fabrication
techniques.

Figure #1 shows a TFEL structure cross section
which consists of two 2000 $\overset{o}{A}$ thick yttrium oxide layers.
Sandwiched between them is a 4000 $\overset{c}{A}$ thick ZnS:Mn:C layer.
When the yttrium oxide is deposited the oxygen is shut off
during the deposition of 200 $\overset{c}{A}$ thick layers immediately adjacent
to both sides of the zinc sulfide. Aluminum electrodes, identical
to those in the TFT circuits, are deposited upon the TFEL
structure; these electrodes are registered to the electrodes
pad in the TFT circuits. Next, a photoresist layer is laminated
over the active area (ZnS covered area of the panel) and via
holes etched in it, is registered to the electrode pads.
Finally, a 5000 $\overset{o}{A}$ thick aluminum layer is deposited over the
whole photoresist to make electrical contact to the aluminum pads
on the top of the TFEL structure through the holes.

Shown therefore is means of fabricating a thin
addressable display panel on a glass substrate that incorporates
a thin film transistor circuit to excite a two dimensional
array of electroluminescent dots, the brightness of each dot
being individually controlled by external signals applied
to the control electrodes. Isolation between the TFT circuit
source for the TFEL is obtained, wherever the panel is to remain
inactive, by interposing a thick layer of an insulator between
the last yttrium oxide layer of electroluminescent structure,
and the heavy back electrode that is connected to the TFEL excitation
source. This, in effect, puts small capacitance in series with the
TFEL at those places, thereby reducing the voltage across the TFEL
structure. The very steep brightness voltage characteristic of the
TFEL results in permanently inactive regions being those at which
the thick insulator has been removed, allowing the heavy back
electrode to make contact with the top yttrium oxide layer
of the TFEL structure. The holes in the thick insulator are placed
so as to be aligned with conducting pads that are a part of the
underlying thin film transistor circuit. Light is generated
in the TFEL structure only in the vicinity of the holes in the
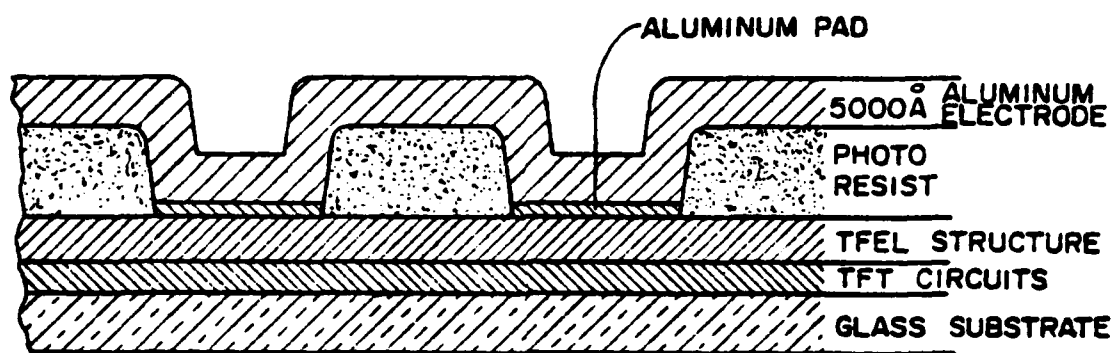heavy insulator.

FIGURE 1. TFEL STRUCTURE

MULTIPACTOR DRIVEN INJECTION LASER
by Charles N. DeSantis and Joseph D. Evankow, D-2281

A technique is disclosed which allows extremely fast
modulation of light for fiber optic communications, communication
systems and target acquisition (CS-TA), and in general,
for radio frequency (RF) energy converted to light energy. In
CS-TA field units, such new biasing mechanisms could
accomplish improved resolution of a target image. As shown in
Figure 1, an injection laser A may be placed between two plates
in an evacuated area, and a space charge cloud caused by a multipactor
may be made to move between the plates. Window E allows
modulated light to escape. An electron space charge cloud,
which may be formed by thermionic or nuclear emission, moves
vertically in either direction between the plates and
when moving past the injection laser, a forward bias condition
will exist and lasing will result. By adding semiconductor
material of a high secondary emission ratio, the multipactor
can be initiated at lower power input levels. The semiconductor
layers may be formed by epitaxial methods. Cavity size is made
proportionally smaller with frequency; epitaxial methods are among
the best choices for fabrication. The ratio of secondary emission
which is present may be controlled by a dc bias applied at a
lower layer A', thus allowing varied power input and maintenance
of constant electron emission by a controlling of the rate of
emission through biasing. The semiconductor might also be
located outside the vacuum chamber, as in Figure 2, thus
eliminating the problem, at higher frequencies, of placing lasers
in the vacuum. It is well to forward bias the laser for
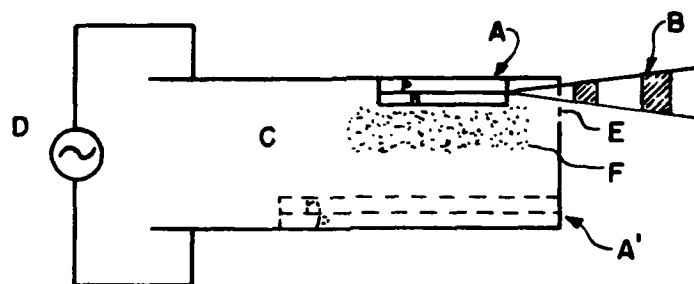increased sensitivity if voltage swing used by the multipactor
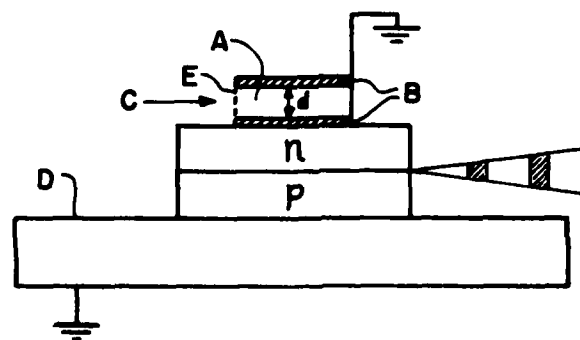proves insufficient.

FIGURE 1. MULTIPACTOR LASER

FIGURE 2. MULTIPACTOR LASER-
EXTERNAL SEMICONDUCTOR

TRANSPARENT ELECTRODE FOR LONG-LIFE ELECTROLUMINESCENT PHOSPHOR LAMPS
by J.X. Przybysz, D-2267

The invention is a vacuum-evaporated transparent electrode for electroluminescent phosphor lamps. The device is particularly well-suited to application with flat panel electroluminescent displays of the thin film transistor(TFT)-addressed design. The electrode is composed of layers of CdF_2 and Au. This new composition is chemically compatible with the CdS-ZnS powder phosphor and results in longer life for the phosphor lamp than previous electrodes.

The beneficial effect of the new composition results from increased chemical compatibility between the electrode and the powder phosphor. The ZnS/Cds powder phosphor is known to be extremely sensitive to its chemical environment. Moisture is very detrimental to long life, and lead oxides can be suspected as well. With standard heats of formation for PbO=-52, CdS=-34, and ZnS=-48 kcal/mole, these basic components of the system are energetically unstable against formation of $PbSO_4$=-219, $PbSO_4 \cdot 3PbO$ = -403, $ZnSO_4$ = -234, and $CdSO_4$=-221 kcal/mole. The new dielectric, CdF_2, with heat of formation -165 kcal/mole is inherently more stable and also less chemically reactive with CdS and ZnS.

In these applications using electroluminescent phosphors, the lamp is constructed by embedding powder phosphor particles in a plastic binder. The thin layer of phosphor/binder (~1 mil) is sandwiched between two conducting electrodes. The phosphor is excited by the application of an alternating voltage to the electrodes. Because powder phosphors are used in flat

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panel TFT-addressed displays, the lamps are constructed by
putting an opaque metal electrode on a glass substrate and
applying the phosphor/binder mix to this electrode. A transparent
top electrode is then evaporated on top of the plastic binder.
The top electrode consists of 50$\overset{\bullet}{A}$ of an insulating dielectric
CdF_2, followed by 75$\overset{\circ}{A}$ of a thin transparent, conducting gold film.
The dielectric film is necessary to obtain good adhesion of metal
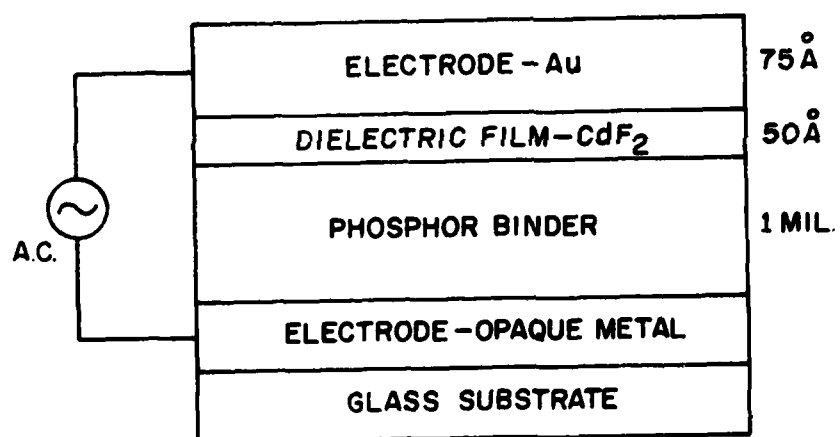film to the thermoplastic binder.

FIGURE 1. TFT–ADDRESSED DISPLAY LAMP

METHOD FOR RAPID START OF HYDROGEN DESORPTION FROM Mg-ALLOY
GRAPHITE HYDROGEN STORAGE MODULES
by Frederick Rothwarf, D-1998

A method is provided for the rapid desorption of
hydrogen from Mg-alloy graphite storage modules. The method
is useful in combustion engines, fuel cells, and other devices
using hydrogen fuel. According to the method, heat is rapidly
introduced into the modules so as to effect the rapid and
continuous desorption of hydrogen for use as a fuel or in other
applications requiring a continuous flow of hydrogen.

More specifically, the invention encompasses first
the fabrication of Mg-alloy graphite composites in the form of
long rods or circular or rectangular cross-section. The rods
are then assembled parallel to one another in an array such that
each rod is electrically insulated from its neighbors by thin
sheets of some dielectric material, such as teflon or alumina.
Such an array constitutes one hydrogen storage module. The
fuel tank of an automobile for example, using hydrogen as a fuel
consists of several such modules enclosed in a suitable pressure
tight container. The ends of the rods in a given array are
electrically connected in a series-parallel arrangement so that
when a switch connecting the array to a battery is closed, a
suitable electric current flows through the rod elements
causing a rapid I^2R heating to a temperature sufficient to desorb
hydrogen from the rods at a useful pressure. Provision is made
to switch a new module into operation when a given module is
depleted of its hydrogen.

The pressure tight module container is fitted with
suitable gas flow regulating valves, piping for leading the

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hydrogen gas to the automobile engine or device active combustion chamber, and finally with heat exchanges for using the exhaust heat from the engine or device to assist in supplying the heat of desorption to the hydrogen module.

The foregoing description illustrates how one can make use of the unique structural integrity of Mg/graphite composites on hydriding to design modules that can be rapidly desorbed by electrical heating to provide quick starting, hydrogen-fueled devices. Probable uses include the convenient start-up of automobiles, fuel cells, home heating systems and other devices which will employ hydrogen as a fuel.

The advantage of the invention stems from the fact that Mg-alloy graphite composites maintain their structural integrity after many hydriding/dehydriding cycles. Because a solid has two orders of magnitude better heat diffusivity than does a powder, it is possible to more efficiently introduce heat into such Mg/graphite composite storage modules than would be the case for the powdered hydride materials, FeTi, LaNi$_5$ and CaNi$_5$, which constitute the hydrogen storage beds being tried for automotive and heat pump application.
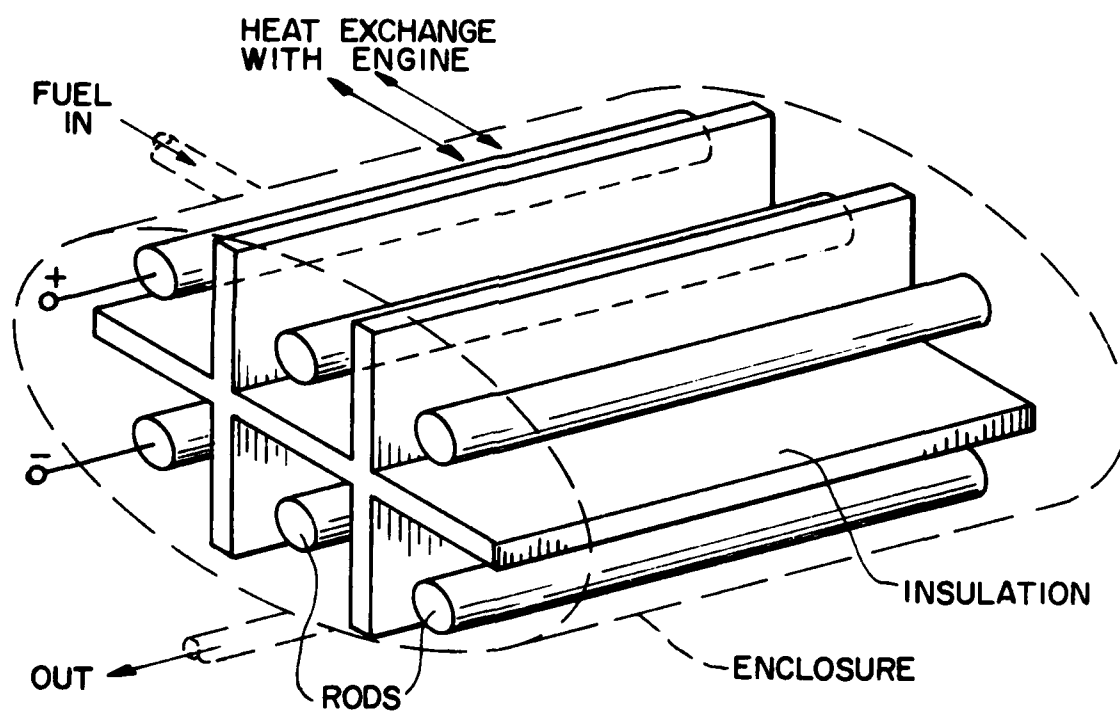
FIGURE 1. HYDROGEN STORAGE MODULE

ENRICHED CADMIUM TELLURIDE CRYSTALS FOR RADIATION DETECTION
by Louis C. Branovich, Willis M. Smith, Stanley DuBuske,
Adolph Hagar and Gerard L. Freeman,   D-2045

A combination of cadmium telluride crystals depleted
in cadmium isotope-113, and cadmium telluride crystals enriched
in cadmium isotope-113, is used to accurately detect thermal
neutrons, gamma, and beta radiation in a thermal neutron
environment. The term depleted refers to a cadmium telluride
crystal that has no, or very little, cadmium isotope-113 in it.
The term enriched refers to a cadmium telluride crystal that
has an atom percent of cadmium isotope-113 greater than that
which occurs in nature (12.27 atom percent to 100.00 atoms
percent).

In the aforedescribed combination, the depleted cadmium
telluride crystals are found to be excellent gamma detectors
in thermal neutron environments. The enriched cadmium telluride
crystals prove to be excellent thermal neutron detectors, and
possess greater sensitivity to neutron radiation when compared
to the natural cadmium telluride crystal detector. The following
reaction may be used as an illustration:

$$_{48}Cd^{113} + _{0}n^{1} \longrightarrow _{48}Cd^{114} + \gamma$$

It may be seen that neutron bombardment of cadmium 113 yields
X-rays, in addition to cadmium 114, which rays would register
during gamma ray readings and result in erroneously high
measurements. However, other non-113 cadmium isotopes do not
cause this problem. Removal of cadmium 113 therefore, would
yield more accurate readings of neutrons. The invention, therefore,
comprises use of cadmium telluride crystals depleted of cadmium
113 for certain purposes, and enriched in cadmium 113 for other

uses. Enriched cadmium 113 compositions for example, would last
longer and be more efficient in thermal neutron environments.
Depleted cadmium 113 compositions would give accurate results
in the detection of gamma radiation in the presence of thermal
neutrons.

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